4 Quality Assurance Procedures

Quality Assurance Adjustment

Flexural Strength, Air Content, Air Content Range
Thickness
Smoothness
Total Quality Assurance Adjustment

Failed Materials

Appeals

Flexural Strength Appeal for Sublot
Air Content Appeal for Sublot

CHAPTER FOUR:
QUALITY ASSURANCE PROCEDURES

Quality Assurance specifications require that the acceptance of material be the responsibility of INDOT. The specification addresses specifically:

1) The units of material quantity used for acceptance.

2) The process of obtaining random samples

3) What mixture characteristics are considered of critical importance

4) At what test values may the mixture be accepted at 100% payment

5) At what levels may the mixture serve at less than design intent and still be of value, and be paid at some adjusted price.

6) At what level should rejection of the material be considered

7) An appeal procedure for resolving disagreements in QC and QA test results

This chapter discusses the procedures and requirements for sampling, testing, and payment of QC/QA PCCP.

SUBLOTS AND LOTS

Quality Assurance Specifications consider a sublot as typically 2400 yd^2. A partial sublot of 480 yd^2 or less is considered as part of the previous sublot and a partial sublot greater than 480 yd^2 is considered an individual sublot.

A lot typically consists of three sublots or 7200 yd^2 of concrete for each mix design. If there is one or two sublots in an incomplete lot, then the quantity of material is considered a lot. Therefore, a lot may contain one, two, or three sublots. If the concrete is placed at several locations on one contract, then the sublots are determined in the order that the material was placed.

Lots and sublots are numbered and tested for a given pay item regardless of the number of CMD's used and are closed out at the end of the paving season or construction phase.

RANDOM SAMPLING

Sampling of material for acceptance testing is done by INDOT on a random basis using **ITM 802**. A random target area for plastic concrete within a sublot is determined and the location of the random quantity is established. Cores for thickness are determined by establishing random longitudinal and transverse locations. The random locations are not given to the Contractor so that there is no possible influence on the production operations.

RANDOM NUMBERS

A table of Random Numbers from **ITM 802** (Figure 4-1) is used to determine the random quantity to sample. The numbers occur in this table without aim or reason and are in no particular sequence. Therefore, samples obtained by the use of this table are truly random or chance and eliminate any bias in obtaining samples.

To use this table to determine the random square yard of concrete to sample, one block is selected in the table. After the block is selected the top left number in the block is used as the first random number. This number is the beginning number for the contract. Additional numbers are obtained by proceeding down the column. The top of the next column on the right is used when the bottom of the column is reached. When the bottom of the last column on the right is reached, the top of the column at the left is used. If all numbers in the table are used before the contract is completed, a new starting number is selected and the same procedure is repeated.

To use this table to determine the location of the pavement core, again a block in the table is selected and the top left number is used. This number is used to determine the test site station. The adjacent number within the block is used to determine the transverse distance to the random site. Additional numbers are obtained by proceeding down by pairs until the bottom numbers are reached and proceeding to the adjacent top block to the right, if available. When the bottom pair of numbers on the right are reached, the top block on the left in the table is used.

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0.576	0.730	0.430	0.754	0.271	0.870	0.732	0.721	0.998	0.239
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.508	0.749	0.291
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.310	0.253	0.761
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.040	0.463
0.053	0.899	0.554	0.627	0.427	0.760	0.470	0.040	0.904	0.993
0.810	0.159	0.225	0.163	0.549	0.405	0.285	0.542	0.231	0.919
0.081	0.277	0.035	0.039	0.860	0.507	0.081	0.538	0.986	0.501
0.982	0.468	0.334	0.921	0.690	0.806	0.879	0.414	0.106	0.031
0.095	0.801	0.576	0.417	0.251	0.884	0.522	0.235	0.389	0.222
0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608	0.698	0.683
0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977	0.796	0.996
0.165	0.996	0.356	0.375	0.654	0.979	0.815	0.592	0.348	0.743
0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787	0.358	0.595
0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871	0.698	0.539
0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466
0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212
0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019
0.068	0.242	0.777	0.356	0.195	0.313	0.396	0.460	0.740	0.247
0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.701	0.326
0.897	0.877	0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284
0.876	0.969	0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802
0.190	0.696	0.757	0.283	0.777	0.491	0.523	0.665	0.919	0.246
0.341	0.688	0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696
0.846	0.355	0.831	0.218	0.945	0.364	0.673	0.305	0.195	0.887
0.882	0.227	0.552	0.077	0.454	0.731	0.716	0.265	0.058	0.075
0.464	0.658	0.629	0.269	0.069	0.998	0.917	0.217	0.220	0.659
0.123	0.791	0.503	0.447	0.659	0.463	0.994	0.307	0.631	0.422
0.116	0.120	0.721	0.137	0.263	0.176	0.798	0.879	0.432	0.391
0.836	0.206	0.914	0.574	0.870	0.390	0.104	0.755	0.082	0.939
0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.702	0.183
0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

Figure 4-1. Random Numbers

The location where the random sample is obtained is calculated using the random target area procedure of **ITM 802** as follows:

1) Determine the sublot size from which a random location is required to the nearest 1 yd^2

2) Divide the area by 100 and round down to the nearest whole number. The resulting number is the number of segments within the area that are available for sampling.

3) Divide the area by the number of sample segments to determine the sample segment size to the nearest 1 yd^2.

4) Select a random number

5) Multiply the number of sample segments by the random number and round down to the nearest whole number. The resulting number represents the random target area. The sample is taken from material placed within the random target area.

6) Divide the sample segment size by the width of the area and round to the nearest 0.1 foot length. The resulting number is the length of the random target area.

7) Multiply the random target area by the length of the random target area and round to the nearest whole foot. The resulting number is the distance to the beginning of the random target area as measured from the start of the area to be sampled.

The following examples explain the procedure for obtaining the random target area:

Example No. 1

A PCCP is being placed at a width of 12 ft and the starting station of the sublot is 102+50. The sublot size is 2400 yd^2.

$$\text{Number of Sample Segments} = \frac{2400}{100} = 24$$

$$\text{Sample Segment Size} = \frac{2400}{24} = 100 \text{ yds}^2$$

Random Number = 0.830

Random Target Area = 24 x 0.830

= 19.9 (Round down to 19)

$$\text{Length of Random Target Area} = \frac{\text{Sample Segment Size (yd}^2\text{)}}{\text{Width (nearest 0.1 ft)}} \times \frac{9 \text{ ft}^2}{1 \text{ yd}^2}$$

$$= \frac{100}{12} \times 9$$

$$= 75 \text{ ft}$$

Distance to the beginning of the Random Target Area = 19 x 75
= 1425 ft

The sample is obtained at 1425 feet from the beginning station of the sublot (102 + 50).

Example No. 2

A PCCP is being placed at a width of 24 ft and the starting station of the sublot is 165+00. The sublot size is 550 yd^2.

$$\text{Number of Sample Segments} = \frac{550}{100} = 5.5 \text{ (Round down to 5)}$$

$$\text{Sample Segment Size} = \frac{550}{5} = 110 \text{ yd}^2$$

Random Number = 0.361

Random Target Area = 5 x 0.361 = 1.8 (Round down to 1)

$$\text{Length of Random Target Area} = \frac{\text{Sample Segment Size (yd}^2\text{)}}{\text{Width (nearest 0.1 ft)}} \times \frac{9 \text{ ft}^2}{1 \text{ yd}^2}$$

$$= \frac{110}{24} \times 9 = 41.2 \text{ ft}$$

Distance to the beginning of the Random Target Area = 1 x 41 = 41 ft.

The sample is obtained at 41 feet from the beginning station of the sublot (165 + 00).

SAMPLE LOCATION -- CORES

The location where the random core for thickness is obtained using the random location per area procedure of **ITM 802** is as follows:

1) Identify the sublot from which a random location is required

2) Select a pair or random numbers from the random number table (Figure 4-1). Use the first number for the longitudinal location and the second number for the transverse location.

3) Determine the length of the sublot

4) Multiply the longitudinal length by the first random number

5) Multiply the transverse width by the second random number

6) The resulting numbers represent the random location

The station at which a core is taken is determined using the length of pavement required for the sublot of PCCP. The transverse distance is determined using the width of pavement being placed, and is measured from the right edge of the lane determined by looking in the direction of increasing station numbers. Computations for the longitudinal distance and the transverse distance are made to the nearest 1 foot. Cores are not taken at the following locations:

1) Less than 6 in. from the edge of pavement

2) Less than 2 ft from a D-1 contraction joint

3) Less than 3 in. from the longitudinal joint

4) Less than 5 ft from a transverse construction joint

If a core location is less than 6 in. from the edge of pavement, a new location is determined by subtracting or adding 6 in. from the random transverse distance. If a core location is over a dowel bar, a new location is determined by subtracting or adding 3 ft from the random station. If a core location is less than 5 ft from a transverse construction joint, a new location is determined by subtracting or adding 5 ft from the random station.

Example:

A PCCP is being placed at a width of 12 feet and the starting station of the sublot is 75+00. The sublot size is 2400 yd^2.

$$\text{Length of Sublot} = \frac{\text{Sublot Size}(yd^2)}{\text{Width (nearest 1 ft)}} \times \frac{9\ ft^2}{1\ yd^2}$$

$$= \frac{2400}{12} \times 9 = 1800\ ft$$

Random Numbers = 0.935, 0.114

Longitudinal Distance = 1800 x 0.935 = 1683 ft

Random Station = (75+00) + (16+83) = 91+83

Transverse Distance = 12 x 0.114 = 1.4 ft (say 1 ft)

SAMPLING PROCEDURES

AASHTO T 141 is the test method required for sampling freshly mixed concrete. An exception to this test method that INDOT allows is that the entire sample may be obtained from one portion of the load. Obtaining a representative sample of the concrete to be tested is important for assuring an accurate determination of the concrete properties. The test results are not acceptable if any sample is improperly taken. Representative material is important for samples taken by the Contractor for job control, samples taken by independent testing companies, and samples that are used to appeal INDOT test results. Although **AASHTO T 141** does not define the sampling container, other test methods are very specific on acceptable types of containers. A wheelbarrow meets the requirements of all the AASHTO test methods used for acceptance testing of concrete by INDOT and therefore is generally used as the sampling and mixing container.

INDOT test samples are obtained at the point of placement whenever possible. QC/QA PCCP samples are taken on the grade after the material has been placed by a material transfer machine, but before the concrete paver has distributed the mixture

INDOT allows two types of freshly mixed plastic concrete samples:

1) A composite sample consisting of two or more increments taken from the batch and mixed together in the sampling receptacle

2) One large increment taken from one portion of the load

The type of sample required is determined by the sampling technique method.

Regardless of where the sample is obtained, no more than 15 minutes should elapse between obtaining the first and final portions of the sample. Also, no sample is obtained before approximately 10 % of the load has been discharged or after approximately 90 % of the load has been discharged.

Sampling from Trucks

When sampling from a revolving drum truck mixer (transit-mix truck) or an agitator truck, the sample may be obtained by directing the chute to a wheelbarrow (Figure 4-2) or to a receptacle on the ground near the testing site. The sample is not obtained from the chute of the truck or from the discharge stream of the concrete when filling the receptacle.

Figure 4-2. Sampling from Truck

Sampling from Grade

When sampled from the grade (Figure 4-3), the sample is taken before any machinery comes in contact with the concrete.

When the sample is obtained from a pile on the grade or the ground near the testing site, samples are taken from five different portions of the pile. The sample should not be contaminated with the base material.

After obtaining the concrete sample, all portions of the concrete are mixed together with a shovel the minimum amount necessary to obtain proper uniformity.

Figure 4-3. Sampling from Grade

Sampling from Central Mixed Plants

When a concrete sample is tested at a central mixed plant, such as would be required for a trial batch or for casting concrete beams, the procedure for sampling the concrete is to have the plant discharge a load directly into the bucket of a loader (Figure 4-4).

Figure 4-4. Loading a Bucket

The loader bucket is cleaned ahead of time to minimize any possible contamination of the sample. The loader then transports the material to the testing location where the concrete is sampled (Figure 4-5).

Figure 4-5. Sampling from a Loader

After sampling the concrete, all portions are thoroughly mixed together with a shovel the amount necessary to obtain proper uniformity (Figure 4-6).

Figure 4-6. Mixing Sample

TESTING EQUIPMENT CALIBRATION

All concrete job-control testing equipment is required to be calibrated at the proper frequency. The calibration process includes sieves, electronic scales, air test equipment, slump equipment, thermometers, and equipment for determination of the unit weight of concrete. Flexural strength testing machines and compressive strength testing machines are required to be calibrated annually and after being moved.

Flexural strength testing machines used by the Contractor on QC/QA contracts are required to also be calibrated. The calibrations of the equipment at these locations are the responsibility of the Contractor. Calibration documentation should be produced by the Contractor for each testing machine and reviewed by INDOT personnel prior to the use of the testing machine for testing concrete for INDOT work.

The following documents should be reviewed for calibration:

1) **AASHTO T 152** - Air Meter and Unit Weight Containers

2) **ITM 902** – Sieves

3) **ITM 903** – Ovens

4) **ITM 910** – Electronic Balances

5) **ITM 911** - Slump Cones

REFERENCED DOCUMENTS

ITM and AASHTO test methods are used for concrete job control. INDOT specifications contain several exceptions to the AASHTO test methods. If there are INDOT exceptions to AASHTO, then INDOT specifications take precedent over AASHTO test methods. The AASHTO test methods and Section **505** should be reviewed for any corresponding exceptions. The Supplemental Specifications and/or Special Provisions of a contract may have additional or different exceptions than those found in Section **505**. All three documents should be reviewed prior to placing concrete on the contract.

SAFETY

Prolonged exposure of skin and tissue to the cement in concrete may be harmful. Therefore, plastic or latex gloves are recommended during the sampling and testing of concrete. Protective eye wear is also recommended because concrete may splatter during testing.

ACCEPTANCE TESTING

The Contractor is required to submit a mix design and provide verification of the design by the Trial Batch Demonstration. The concrete properties are required to meet the concrete parameters of the Specifications prior to placement.

Acceptance testing results are shared with the Contractor. The flexural strength, air content, unit weight, water/cementitious ratio, and thickness are measured for acceptance. The frequency, test method, and precision of test results are as follows:

Test or Determination	Frequency	Test Method	Precision
7-Day Flexural Strength	Two beams per sublot	AASHTO T 97	10 kPa (1 psi)
Air Content	One per sublot	AASHTO T 152 or ASTM C 173	0.1
Unit Weight	One per sublot	AASHTO T 121	1
Water/Cementitious Ratio	One per two lots	ITM 403	0.001
Thickness	Two per sublot	ITM 404	0.1

FLEXURAL STRENGTH

The average lot values for flexural strength are required to be a minimum of 570 psi. Price adjustments for values below 570 psi are required.

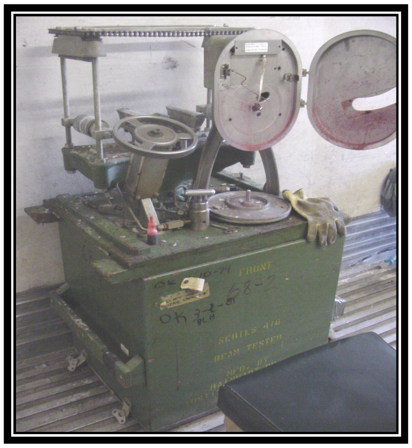

Figure 4-7. Flexural Strength Machine

AASHTO T 97 is the test method used for determining the flexural strength of concrete beams. This test consists of breaking the test beams on a self-recording beam breaker and calculating the flexural strength results. Sections **502.18**, **702.05**, and **702.13(h)** include the flexural strength requirements.

AIR CONTENT

The average lot air content is required to not vary more than - 0.8 % or + 2.4 % from the 6.5 % target air content. Also, the range of values is required to not exceed 2.5 %. Range is defined as the difference between the highest sublot air content and the lowest air content sublot within a lot. Price adjustments are required for exceeding the tolerances for air content and the range of air content.

Pressure Method

AASHTO T 152 is the required test method for determining the air content of freshly mixed concrete by the Pressure method. An aggregate correction factor is required and is dependent on the source of the fine aggregate, the source of the coarse aggregates and ledges for stone, and the percentages of each used in the mix. The aggregate correction factor should therefore be checked each time one of these factors changes. An aggregate correction factor determination is required for each CMD.

Figure 4-8. Type B Air Meter

Volumetric Method

The volumetric method for air content (**AASHTO T 196**) is required by INDOT when porous aggregate such as air-cooled blast furnace slag is specified; however, this test method may be used on concrete containing any type of aggregate.

Figure 4-9.Volumetric Air Meter

UNIT WEIGHT

The sublot unit weight is required to not vary more than ± 3.0% from the target unit weight. A stop paving order is issued if the plastic unit weight exceeds the ± 3.0 % tolerance. Paving operations are not allowed to resume until satisfactory changes are made or an alternate CMD is used.

AASHTO T 121 is the test method required for determining the unit weight of the freshly mixed concrete (Figure 4-10). **AASHTO T 121** requires the use of a 24-inch tamping rod and **AASHTO T 152** requires only a 16-inch tamping rod. Since the unit weight and the air content are generally determined at the same time, a 24-inch tamping rod is used to meet the requirements of both methods. Also an exception in **505.01(c)** requires that the weight be determined to the nearest 0.01 lb.

Figure 4-10. Unit Weight

WATER/CEMENTITIOUS RATIO

The water/cementitious ratio is required to not vary by more than ± 0.030 from the target value or exceed a value of 0.450. A stop paving order is issued if the test results exceed these values. Paving operations are not allowed to resume until satisfactory changes are made or an alternate CMD is used.

ITM 403 is used for determining the water/cementitious ratio of concrete. Representative sampling of the fine aggregate and the coarse aggregate for moisture content is critical to determine this value on the day of the concrete pour. If the moisture content of the aggregates changes (e.g. overnight rain), then the batch weights are required to be changed accordingly to maintain the proper proportions of materials to produce a cubic yard of concrete.

The W/C ratio calculation is determined from the amount of free water in the concrete batch. The free water is the total of all water added at the jobsite plus the water on the aggregates in excess of the amount of water required to satisfy the absorption of the fine and the coarse aggregates.

Free water is expressed in pounds of water per pound of cement and the ratio of the two is called the water to cementitious ratio. If pozzolans are included in the concrete mixture, then the weight of pozzolans is added to the cement weight for this calculation. A form in **ITM 403** is used to calculate the W/C ratio.

THICKNESS

The PCCP thickness is required to be determined after all corrective grinding of the pavement, if necessary, is completed. The Contractor is required to obtain two 4 in. diameter cores for each sublot (Figure 4-11). The cores are taken the full depth of the PCCP at the locations determined by the PE/PS in accordance with **ITM 802**; however, cores are not taken in the following locations:

1. Less than 2 ft from the edge of pavement
2. Less than 2 ft from a D-1 contraction joint
3. Less than 3 in. from the longitudinal joint
4. Less than 5 ft from a transverse construction joint

Figure 4-11. Concrete Coring

The cores are taken and measured with a core length apparatus (Figure 4-12) in accordance with **ITM 404** at 10 locations on the core. The average of these measurements is considered the length of the core.

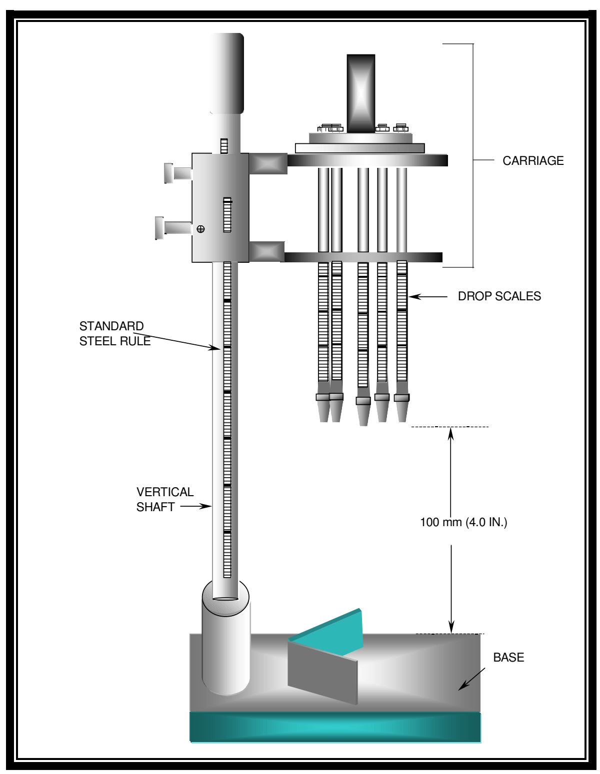

Figure 4-12 . Core Length Apparatus

The thickness of the PCCP for each sublot is the average lengths of both cores from the sublot. The sublot pay factor is determined by subtracting the design thickness from the average sublot thickness and comparing this value to the allowable tolerances. Values exceeding ± 0.2 inches are required to have a price adjustment.

SMOOTHNESS

As soon as the concrete has cured enough to permit testing, the profile of the pavement is required to be checked for smoothness. INDOT may require that the pavement be tested within 24 h following the placement of the concrete. This requirement is continued until the paving operation is consistently providing pavement meeting the smoothness requirements without corrective action. All remaining pavement is to be checked for smoothness before opening to traffic or before work is suspended for the winter.

Smoothness is checked by one of three methods:

1) A profilograph (Figure 4-13) is used on all mainline traveled ways and ramps, including adjacent acceleration or deceleration lanes where both the design speed is greater than 45 mph and the traveled way or ramp lane width is constant and is 0.1 mi. in length or longer.

Figure 4-13. Profilograph

If the posted speed limit is greater than 45 mph for a portion of a smoothness section and is less than or equal to 45 mph for the remainder, the section smoothness acceptance is as follows:

a. By profilograph for the portion of the section with a posted speed limit greater than 45 mph

b. By 16 ft straightedge for the portion of the section with a posted speed limit less than or equal to 45 mph

2) For contracts which include a requirement for profilograph testing, a 16 ft straightedge is used at the following locations:

   a. All mainline traveled way lanes shorter than 0.1 mi.
   b. All mainline traveled way lanes within smoothness sections with posted speed limits less than or equal to 45 mph throughout the entire section length
   c. All mainline traveled way lanes at locations exempted from profilograph operation in accordance with **ITM 912**
   d. All tapers
   e. All turn lnes, including bi-directional left turn lanes
   f. All ramps with design speeds of 45 mph or less
   g. All acceleration and deceleration lanes associated with ramps with design speeds of 45 mph or less
   h. All shoulders

3) A 10 ft straightedge is used on transverse slopes, approaches, and crossovers

Profile smoothness is checked 3 ft from, and parallel to, the outside edge of each lane up to 12 ft wide. Lanes wider than 12 feet are checked 3 ft from both edges. Any curing compound removed during straightedging should be replaced immediately.

When correction is needed, a groove type cutter is used to grind the pavement to the proper smoothness while maintaining the required skid resistance.

The required surface tolerances for QC/QA pavements are:

1) 16 ft straightedge – 1/4 in. or less
2) 10 ft straightedge – 1/8 in. or less

In addition to the requirements for the profile index for the profilogragh, any area having a high point deviation in excess of 0.3 in. is required to be removed.

PAY FACTORS

Pay factors are determined for flexural strength, air content, air content range, thickness, and smoothness. When the PCCP test results exceed the allowable tolerances, pay factors are determined.

FLEXURAL STRENGTH

Pay factors for flexural strength are assessed as follows:

Lot Average Flexural Strength	
psi	**Pay Factors**
570 and above	1.00
565 - 569	0.98
560 - 564	0.96
555 - 559	0.94
550 - 554	0.92
545 - 549	0.89
540 - 544	0.86
535 - 539	0.83
525 - 534	0.78
515 - 524	0.72
514 or less	*

*The PCCP is adjudicated as a failed material in accordance with normal INDOT practice as listed in Section **105.03**. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.

AIR CONTENT

Pay factors for air content are assessed as follows:

Lot Average Air Content	
Percent %	**Pay Factors**
> 9.8	*
9.7 – 9.8	0.80
9.5 - 9.6	0.90
9.3 - 9.4	0.95
9.0 - 9.2	0.99
5.7 - 8.9	1.00
5.6	0.93
5.5	0.90
5.4	0.85
5.3	0.79
< 5.3	*

*The PCCP is adjudicated as a failed material in accordance with normal INDOT practice as listed in Section **105.03**. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.

AIR CONTENT RANGE

The lot air content range is assigned pay factors in accordance with the following::

Lot Range for Air Content	
Percent %	**Pay Factors**
0.0 - 2.5	1.00
2.6 - 3.0	0.99
3.1 - 3.5	0.97
> 3.5	*

*The PCCP is adjudicated as a failed material in accordance with normal INDOT practice as listed in Section **105.03.** The PCCP may be subject to removal and replacement or left in place with reduced or no payment.

THICKNESS

The sublot core thickness is assigned a pay factor in accordance with the following:

Sublot Pay Factors For Thickness Average Core Depth (ACD) Design Depth (DD)	
ACD Minus DD	**Pay Factor**
> +0.5 in. (> +13 mm)	1.05
+ 0.3 in. to +0.5 in. (+ 7 mm to +13 mm)	1.02
0.2 in.(± 6 mm)	1.00
- 0.3 in. to - 0.5 in. (- 7 mm to - 13 mm)	0.96
- 0.6 in. to - 0.7 in. (- 14 mm to - 19 mm)	0.90
- 0.8 in. to - 1.0 in. (- 20 mm to - 25 mm)	0.80
< - 1.00 in. (< - 25 mm)	*

SMOOTHNESS

When pavement smoothness is tested with a profilograph, pay factors are determined for each 0.1 mile long sections represented by the profile index. The pay factors are calculated in accordance with the following table:

Section Pay Factors for Smoothness Zero Blanking Band	
Design Speed Greater Than 45mph	
Profile Index in./0.1 mi.	**Pay Factor**
Over 0.00 to 1.40 in.	1.06
Over 1.40 to 1.60 in.	1.05
Over 1.60 to 1.80 in.	1.04
Over 1.80 to 2.00 in.	1.03
Over 2.00 to 2.40 in.	1.02
Over 2.40 to 2.80 in.	1.01
Over 2.80 to 3.60 in.	1.00
Over 3.60 to 3.80 in.	0.96
All pavements with a Profile Index ($PI_{0.0}$) greater than 3.80 in. shall be corrected to 3.80 in.	

QUALITY ASSURANCE ADJUSTMENT

The pay factors are used to calculate a quality assurance adjustment quantity for the lot. The adjustment for flexural strength, air content, air content range, thickness and smoothness are calculated as follows:

FLEXURAL STRENGTH, AIR CONTENT, AIR CONTENT RANGE

For flexural strength, air content, and air content range determination:

$q = L \times U \times (P - 1.00)$

where:

q = quality assurance adjustment quantity
L = lot quantity
U = unit price for QC/QA-PCCP, ($/yd^2$)
P = pay factor

THICKNESS

For sublot thickness determination:

$q_T = l_T \times U \times (P - 1.00)$

where:

q_T = quality assurance adjustment quantity
l_T = sublot quantity for thickness
U = unit price for QC/QA-PCCP, ($/yd^2$)
P = pay factor

SMOOTHNESS

For section smoothness determination:

q_s = $(PF_s - 1.00) \times A \times U$

where:

q_s =quality assurance adjustment for smoothness for one section
PF_s = pay factor for smoothness
A = area of the section, (SYS)
U = unit price for the material, ($/SYS)

The quality assurance adjustment for smoothness for the contract, Q_S, will be the total of the quality assurance adjustments for smoothness, q_s, on each section as follows:

$$Q_s = \Sigma\, q_s$$

TOTAL QUALITY ASSURANCE ADJUSTMENT

The total quality assurance adjustments are calculated as follows:

$Q_T = \Sigma\, (q_{T1} + q_{T2} + q_{T3})$, and

$Q = \Sigma\, (q_F + q_A + q_R + Q_T) + Q_S$

where:

Q = total quality assurance adjustment quantity
Q_S = quality assurance adjustment for smoothness
q_F = lot quality assurance adjustments for flexural strength
Q_T = lot quality assurance adjustments for thickness
q_A =lot quality assurance adjustments for air content
q_R = lot quality assurance adjustments for range

Example:

The PCCP has the following test results. Determine the Quality Assurance Adjustments for the lot.

Sublot 1 = 2400 yd^2
Sublot 2 = 2400 yd^2
Sublot 3 = 2400 yd^2
Design Depth (DD) = 14.0 in.
Quality Assurance Adjustment for Smoothness (Qs) = - $1200

Unit Price = $32.00 sys

	Sublot 1	Sublot 2	Sublot 3	Lot Avg.	Pay Factor
Flexural Strength	565 psi	560 psi	570 psi	565 psi	0.98
Air Content	6.2%	7.4%	5.3%	6.3%	1.00
Air Content Range		7.4 - 5.3 = 2.1%			1.00

q_F = 7200 x 32.00 x (0.98 - 1.00)
= - \$4608

q_A = 7200 x 32.00 x (1.00 - 1.00)
= \$0

q_R = 7200 x 32.00 x (1.00 - 1.00)
= \$0

Thickness

	Sublot 1	Sublot 2	Sublot 3
Sublot Average	14.1 in.	13.9 in.	14.4 in.
Deviation from DD	+0.1 in.	-0.1 in.	+0.4 in.
Pay Factor	100	1.00	1.02
Adjustment Quantity	0	0	+1536

Q_T = 0 + 0 + 1536 = \$1536

Total Quality Assurance Adjustment

$Q = \sum (q_F + q_A + q_R + Q_T) + Q_S$

= (-4608 + 0 + 0 + 1536) + (-1200)

= - \$4272

FAILED MATERIALS

Sublot and lot values that are excessively out of tolerance are required to be submitted to INDOT for final payment. The test value criteria that requires such submittal include:

1. An individual sublot having an air content test value of less than 4.5 percent or more than 10.0 percent

2. An individual sublot having a flexural strength test value less than 500 psi

3. A lot having a flexural strength test value average of 514 psi or less

4. A lot having an air content test value average of less than 5.3 % or greater than 9.8 %

5. A range of air content of greater than 3.5%

6. A core thickness that is less than the design depth required pavement thickness by more than 1.00 in.

As a minimum, the Failed Materials Committee considers the above-noted items for no additional payment adjustment, an increased payment adjustment to offset potential maintenance costs, additional payment to cover the cost of the investigation, no payment, or removal and replacement

APPEALS

If the Contractor does not agree with the acceptance test results for a lot of QC/QA pavement concrete, an appeal may be submitted. The appeal is required to meet the following criteria:

1. Appeals are submitted in writing to the PE/PS within five calendar days of receipt of INDOT's written results for the lot.

2. The submission is required to contain quality control test data that equals or exceeds the number of tests required.

3. The difference between the acceptance test result and the nearest quality control test result is required to be at least 50 psi for flexural strength.

4. The difference between the acceptance test result and the nearest quality control test result is required to be at least 0.5 percent for air content.

Cores are obtained by the Contractor at locations determined by the PE/PS within the appealed sublot. The location of the cores is at the center of a lane at the acceptance sample location. Cores are not taken over dowels or within 5 ft of a header. Each core is required to be 4 in. in diameter for the full depth of the pavement. All core holes are filled by the Contractor with PCC within 24 hours of drilling.

The core value is considered as the flexural strength or air content for the sublot in question and is used to determine all subsequent actions involving the sublot and lot.

FLEXURAL STRENGTH APPEAL FOR SUBLOT

For a flexural strength appeal, two cores are taken within the appealed and adjacent sublots using the same CMD.

Each core is tested for split tensile strength in accordance with **ASTM C 496**. The cores are submerged in lime saturated water prior to testing for a minimum of 40 hours.

The average core split tensile strength is determined for the appealed and adjacent sublots. Flexural strength is calculated as follows.

$$F_D = S_D \times \left[\frac{F_{A1}}{2S_{A1}} + \frac{F_{A2}}{2S_{A2}} \right]$$

where:

F_D = flexural strength of the appealed sublot
F_{A1} = flexural strength of the previous adjacent sublot
F_{A2} = flexural strength of the subsequent adjacent sublot
S_D = split tensile strength of the appealed sublot
S_{A1} = split tensile strength of the previous adjacent sublot
S_{A2} = split tensile strength of the subsequent adjacent sublot

AIR CONTENT APPEAL FOR SUBLOT

For an air content appeal, one core is taken from each sublot. The hardened concrete air content is determined in accordance with **ITM 401** and converted to a value representing the air content in the plastic state.